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# CEWES MSRC Web-Linked Database Projects Developed by NPAC

by

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# CEWES MSRC Web-Linked Database Projects Developed by NPAC

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# Abstract

***This report summarizes two focused efforts with a common theme of coupling commercial database technology with the world-wide web to facilitate the presentation and management of large information spaces. The two project titles are "Web-Linked Databases for Domain-Specific Information Repositories" and "Interfacing Databases and the Web: Management of Large WWW Sites Using Commercial Database Technology". Both projects utilize the Oracle7 relational database system, the Oracle Context Option and the Oracle Web Server. The services provided can be accessed using any standard web browser.***

# Web-Linked Database For Domain-Specific Information Repositories

## Introduction

This project deals with searching out specific useful information from the large amounts of information available on World Wide Web. Along with the growth of Internet, the amount of information on the WWW became increasingly large and it's hard for users to obtain what they want from the huge volume of information in a way that's quick, precise and efficient. This project provides an efficient way for users to locate specific information from the glut of information available on the web. It is a web search engine which centralizes and indexes information about grid generation technologies (as used in computational fluid dynamics, structural mechanics, and other fields). Grid generation expert Joe Thompson of Mississippi State University provided some of the initial information (URLs of major grid generation WWW sites) used to seed the search engine.

## Components And Implementations

At the highest level, the Grid Search System consists of three parts: Robot, Database and Web Interface.

# 1. Robot

The robot consists of four parts, as shown in Figure 1.

Given an initial set of URLs, the robot gathers HTML documents from remote web servers by following all links in the original document set. At present, gathering of documents is controlled simply by limiting the depth to which links will be followed. The current default is a link depth of 4, meaning that documents connected to the initial set by a chain of up to 4 links will be gathered.

## 1.1 Gather

The **gather** subsystem gets the URL to be gathered from the loader (the loader gets the URL from its queue in the database), then opens a network connection by creating a TCP/IP socket to establish communication with a specific HTTP web server, and gathers the HTML document from this web server using the HTTP protocol. Then it parses the document, extracting all links, document size, last update time, total references, images and forms, etc., and formats the document (to guarantee correct loading of the document into the database). Then this information and the formatted document is appended to a temporary file in order to load into the database later. Any URLs found in the document are sent to the inspector subsytem by message communication. ***The gather subsystem is implemented in C***.

## 1.2 Inspector

The i**nspector** subsystem receives URLs from the **gather** subsystem and checks that they belong to the webspace of interest, and that they are not already in the database. If the URL is "valid", it is inserted into the "links" queue in the database to be gathered later, otherwise the URL is discarded. When a valid URL refers to a new web server, a signal is also sent to the Robot_Agent. ***The inspector subsystem is implemented in Pro*C.***

## 1.3 Loader

The **loader** manages semaphore and message communication for the system. It passes URLs to be gathered from the links queue in the database to the gather subsystem, and receives information from the **gather** subsystem (including HTML documents) to be loaded into the database. ***This module is implemented in Pro*C***.

## 1.4 Robot_Agent

This module has the simple task of checking the robot_disallowed file on new web servers. ***It is implemented in Pro*C.***

# 2. Database

The Database part can be divided into three parts: storage, index and search.

## 2.1 Storage

We use the Oracle7 relational database system to store URLs, documents and other information. The layout of the table used to store URLs and related data is shown in Table 1. Each URL occupies a row. Table 2 shows the layout of the table used to store documents and their associated data; each document occupies a row.

| Field | Data Type |
|---|---|
| HOST_ID | NUMBER(6) |
| PROT | VARCHAR2(10) |
| HOST | VARCHAR2(60) |
| PATH | VARCHAR2(250) |
| OLDPATH | VARCHAR2(250) |
| FLAG | CHAR(1) |
| PRIORITY | NUMBER(2) |
| DEPTH | NUMBER(2) |
| FID | NUMBER(8) |

Table 1. Layout of URL storage table

| Field | Data Type |
|---|---|
| FID | NUMBER(8) constraint pk_fid primary key |
| STATUS | NUMBER(1) |
| HOST_ID | NUMBER(6) |
| PROT | VARCHAR2(10) |
| HOST1 | VARCHAR2(60) |
| PATH | VARCHAR2(255) |
| TIME | DATE |
| LTIME | DATE |
| NO_REFS | NUMBER(5) |
| NO_HTML | NUMBER(5) |
| NO_IMGS | NUMBER(5) |
| S_FORM | NUMBER(1) |
| FSIZE | NUMBER(8) |
| TITLE | VARCHAR2(255) |
| SUBJECT | VARCHAR(255) |
| TEXT | LONG |

Table 2. Layout of document storage table.

## 2.2 Index

The index is an optional structure associated with tables and clusters. It provides a faster access path to table data. Properly used, indexes are a primary means of reducing disk I/O. Indexing is used at a fairly low level in the Oracle system, so that the presence or absence of an index does not require changes to any SQL statements, it merely affects the speed of execution.
Indexes are logically and physically independent of the data in the associated table. They can be created or dropped anytime without any effect on the base tables or other indexes. If an index is dropped, all applications continue to work. However, access to previously indexed data might be slower.

Once created, an index is automatically maintained and used by Oracle. Changes to data, such as inserting new rows, updating rows, or deleting rows, are automatically reflected in all relevant indices with no additional action by users. The presence of many indexes for a table decreases the performance of updates, deletes and inserts since the indexes associated with the table must also be updated.

In order to increase the performance of updating, deleting and inserting to document table, we adapt batch index mode to the text of a document. That is to say, we index the text of documents *after* loading all documents. For those non-text columns we use a real-time index, (e.g. URLs id and documents id).

We use the Oracle ConText Option to create an index for document text. First, we define a policy for the text column of the document by calling CTX_DDL.CREATE_POLICY and specify two required parameters: policy name and fully qualified column name for the policy. The example is as shown below:

```
execute ctx_ddl.create_policy('search','search.docs.text')
```

Here, a policy named SEARCH is created for the TEXT column in the DOCS table owned by SEARCH.

After that, we create a text index for the text column by calling the CTX_DDL.CREATE_INDEX procedure. The example is as shown below:

```
execute ctx_ddl.create_index('search')
```

## 2.3 Search

After a text index is created for a column, the ConText Server can process text queries for the column using the previously defined search policy.

The Oracle ConText Option is an add-on component of the Oracle package. It provides powerful search, retrieval, and viewing capabilities for text stored in an Oracle database. These capabilities are implemented in Oracle using a ConText Server process, which complements the usual Oracle

Server processes, and a text index, created by ConText Option, for each database column in which text is stored.

We use the PL/SQL package to implement the queries to the text of documents by calling the CTX_QUERY.CONTAINS procedure. The example is as shown below:

```
ctx_query.contains('SEARCH', 'keyword', 'QUERY_TEMP',)
```

Here, SEARCH is the name of the policy created for the text column, and KEYWORD is the user's query expression. A query expression is a combination of query terms (words and phrases) and components, such as operators, that allow users to specify exactly which documents are to be retrieved.

There are several search options available for querying text, including:

a) Exact word or phrase

b) Associations
-- Stem of a word or phrase
-- Fuzzy match of a word or phrase which allows for mis-spelling
-- Words that sound similar to each other
-- Words specified as LIKE expressions
The expansion operators are shown in table 3.

| Operator | Symbol | Description |
|---|---|---|
| STEM | $ | Expands the list of words to include all words having the same stem or root word |
| FUZZY | ? | Expands the list of words to include all words with similar spelling |
| SOUNDEX | ! | Expands the list of words to include all words that sound the same |

Table 3. The expression operators

c) Proximity
Search for words or phrases that appear close to one another in a document. Documents where the words or phrases are close together will score higher than those where the terms are farther apart.

d) Operators
Any of these options can be logically combined. Logical operators combine the terms in a query expression. All single words and phrases may be combined with logical operators. When query terms are combined, neither the number of spaces around the logical operator, nor the order of the query terms is significant, with exception of the MINUS operator(i.e., "A minus B" is different

from  “B minus A” ). All operators are shown in Table 4:

| Operator | Symbol | Equivalent |
|---|---|---|
| AND | & | and |
| OR | \| | or |
| ACCUMULA | , | accumulate |
| MINUS | - | minus |

Table 4. Logical operators and meaning

**CTX_TEMP** is the results table created before the query is performed. The result table is always called the “hit list” table, and it must have the structure illustrated by the Table 5.

| Field | Data Type |
|---|---|
| TEXTKEY | VARCHAR2(64) |
| SCORE | NUMBER |
| CONID | NUMBER |

Table 5. The architecture to the query results
and relative data type

Using the hit list, the grid search system displays the document list page by page, including title, size, last update time and subject. If the user wants a particular document, he can click on the document’s entry in the list using the  mouse and the whole document will be displayed with the keywords are highlighted.

We implemented viewing document in Pro*C by calling the procedure CTX_QUERY.HIGHLIGHT. This procedure fetches the document, parses the query, identifies the matching terms and insert results into the HIGHLIGHT_TEMP table.
The example is shown in the Table 6.

| Field | Data Type |
|---|---|
| ID | NUMBER |
| OFFSET | NUMBER |
| LENGTH | NUMBER |
| STRENGTH | NUMBER |

Table 6.   HIGHLIGHT_TEMP table payout

Using the offset and length of the keywords in the document, we form the highlighted version of the HTML document.

## 3. Web Interface

In the grid search system, we use Oracle WebServer as our search engine's server. The Oracle WebServer is a HyperText Transfer Protocol (HTTP) Internet Server with unprecedented database integration and a powerful development environment. When the WebServer receives a URL from a browser located either on the World Wide Web or on a local network, it draws on information from the database and the operating system's (OS) file system as necessary to respond to the request. The file system can be used for static (hardcoded) Web pages, or for CGI scripts that do not access the database, and the database is used for Web pages that are generated at runtime using "live" data.

One of the important components of the Oracle WebServer is the Web Listener. It receives a URL from a web browser and sends back the appropriate output. When the Web Listener receives an URL, it determines whether the request requires the use of a service, accessed through the Web Request Broker (WRB); a program, accessed through the CGI interface, or whether access to the file system of the machine on which the Listener resides is sufficient. If WRB access is required, the Listener passes the request to the WRB Dispatcher for processing; then it returns to the task of listening for more incoming HTTP requests.

The Dispatcher maintains communication with a pool of processes called WRB Executable Engines (WRBXs). Each WRBX interfaces to a back-end application using the WRB API. These applications are called WRB cartridges. The PL/SQL agent is one such cartridge. A WRBX that is to use the PL/SQL agent immediately connects to the database when it is created and waits for a request to come in. This enables requests to proceed much more quickly.

The PL/SQL agent executes application code written in PL/SQL and returns the output in HTML form for the Web Listener to output as a Web page. When a URL is received for the PL/SQL agent, it contains a Database Connection Descriptor (DCD). The DCD determines both the database access privileges the PL/SQL agent has when executing this request, and the schema (portion of the database) that it accesses. PL/SQL procedures are stored in the database. The PL/SQL agent invokes these by issuing commands to the database, which then performs the actual execution and sends the output and status messages back to the PL/SQL agent.

Based on Oracle WebServer, we provide the user with a web interface for entering the query string. The user can type any desired search expression . The main Web Interface is shown in **Figure 2**. After accepting the user's query string, the interface calls the PL/SQL package through the PL/SQL agent, and returns the hitlist. The interface is illustrated in **Figure 3**. Then the user can click on the document hitlist to view a particular document with the keywords highlighted. This is illustrated in **Figure 4**.

# WWW Sites Management System Using Commercial Database Technology

## Introduction

The purpose of this project is to couple commercial relational database technology with the World Wide Web (WWW) to make it easier to effectively manage information on WWW sites of large organization such as the CEWES MSRC. This information management will include obtaining overview information, such as web page distribution, last update time, number of images and links, as well as finding “dead links” and “orphaned files”.

## Components and Implementation

This prototype Web Site Management System (WSMS) includes a search engine and structural overview of the site, as well as search capabilities for the structural information. Dead link identification comes naturally from the structural information, and orphan file identification is implemented using a Perl script to get around the fact that the prototype WSMS is not actually installed on the site’s web server system.

### 1. Search Engine

The search engine component of the WSMS is essentially the same as that used for the grid search engine. Of course it only gathers and indexes the document from one specific web server, and it does not use link-depth control to limit gathering of the site. The implementation is the same as that of grid search system and the interface is illustrated in **Figure 5**.

### 2. Structural Summary

This component provides the web site summary information for the webmaster. In order to improve the performance, whenever the database is updated, the web site summary information is generated from database and stored as a static HTML file. It provides the web information as shown as below:

-- ***Total pages:*** The total number of HTML documents on the web site.
-- ***Total linked Images:*** The total number of images linked by documents on the web site.
-- ***Dead links:*** The total number of dead links within the web site.
-- ***Total size:*** The total size of all documents on the web site.
-- ***Longest size:*** The size of the longest document on the web site.
-- ***Shortest size:*** The size of the shortest document on the web site.

This component is implemented using PL/SQL and the interface is illustrated in **Figure 6**.

### 3. Web page distribution structure

For the webmaster, if the web site is big enough, it's always hard to get a handle on how the documents are distributed on the web site. This component provides a mechanism for the webmaster to get such information. It begins with the root directory of the web server and follows all the subdirectories to display the documents and their structural information. It may be different from the real file system directory structure on the web site, because it's based on the information in the database, which only stores the HTML documents obtained by accessing the site's HTTP server. It is implemented using PL/SQL and the interface is illustrated in **Figure 7**.

### 4. Web structure information search

Sometimes the webmaster may want to search the information on the web site according to the document's structure instead of content (keyword search). An interface is provided to allow the structural information described above to be searched. Possible queries include: size, last update time, or number of links or images. This functionality is also implemented using PL/SQL and the interface is illustrated in **Figure 8**.

### 5. Orphan file finder

There are some documents on the web site which can not be referenced by any other document, we refer to these documents as "orphan files". Orphan files can not be gathered by the robot, so they are not stored in the database; they only can be found on the web site's file system. Our orphan file finder can be divided into two parts. One part is located on the database side, and generates the whole document list from the database and stores the list on the database server. It is implemented using Pro*C. The other part is a Perl script located on the web site host system. It gets the document list generated by the first part from the remote HTTP server and compares it with the files in the real file system. Files present on the web site file system, but which are never referred to by other documents in the site are flagged as orphans. It is important to note that "orphan files" may in fact be correct in some cases, such as documents referred to by other web sites, or documents intended for limited distribution.

# Conclusions and Future Vision

These two projects demonstrate the ease and power of coupling commercial database technologies with the world-wide web in working with large information spaces.

The grid search system is representative of focused, domain-specific search engines that can be easily created using this approach. It allows DoD researchers interested in grids and grid generation to extract relevant information easily and efficiently from the flood of information now available on the Internet.  Search engines for other domains are planned, and there is ample scope to improve the algorithms used to filter information as the document is being gathered into the database.

The prototype web site management system uses the same basic facilities as does the search engine to provide a tool to ease the management of large, rapidly changing web sites with many individuals contributing to the content.  When the full system is installed on-site at the CEWES MSRC, it will be possible to serve the web site from the WSMS.  At that point, content providers will be able to check documents into and out of the WSMS, and a security model will provide for concepts of ownership, release approval, and staging of documents from private (pre-release) webspace to public webspace, in addition to the types of support the system already provides to the webmaster.

While useful in their own right, these projects are also meant to serve as more general exemplars of the advantages of coupling databases with the WWW.  The HPCC community historically has not made much use of commercial database technology, despite the large volumes of complex data often arising in their work.  We believe that the ability to put an easily accessible web-based interface onto large databases goes a long way towards lowering the historical barrier to the use of databases in HPCC, and we will use the search engine and WSMS to promote increased use of these technologies by DoD researchers.

# References

1. Oracle Corp.,  Oracle7 Server,  Release 7.3 Reference,  1996
2. Oracle Corp.,  Oracle ConText Option Application Developer's Guide, Release 1.1, 1996
3. Oracle Corp.,  Oracle WebServer User's Guide,  1996

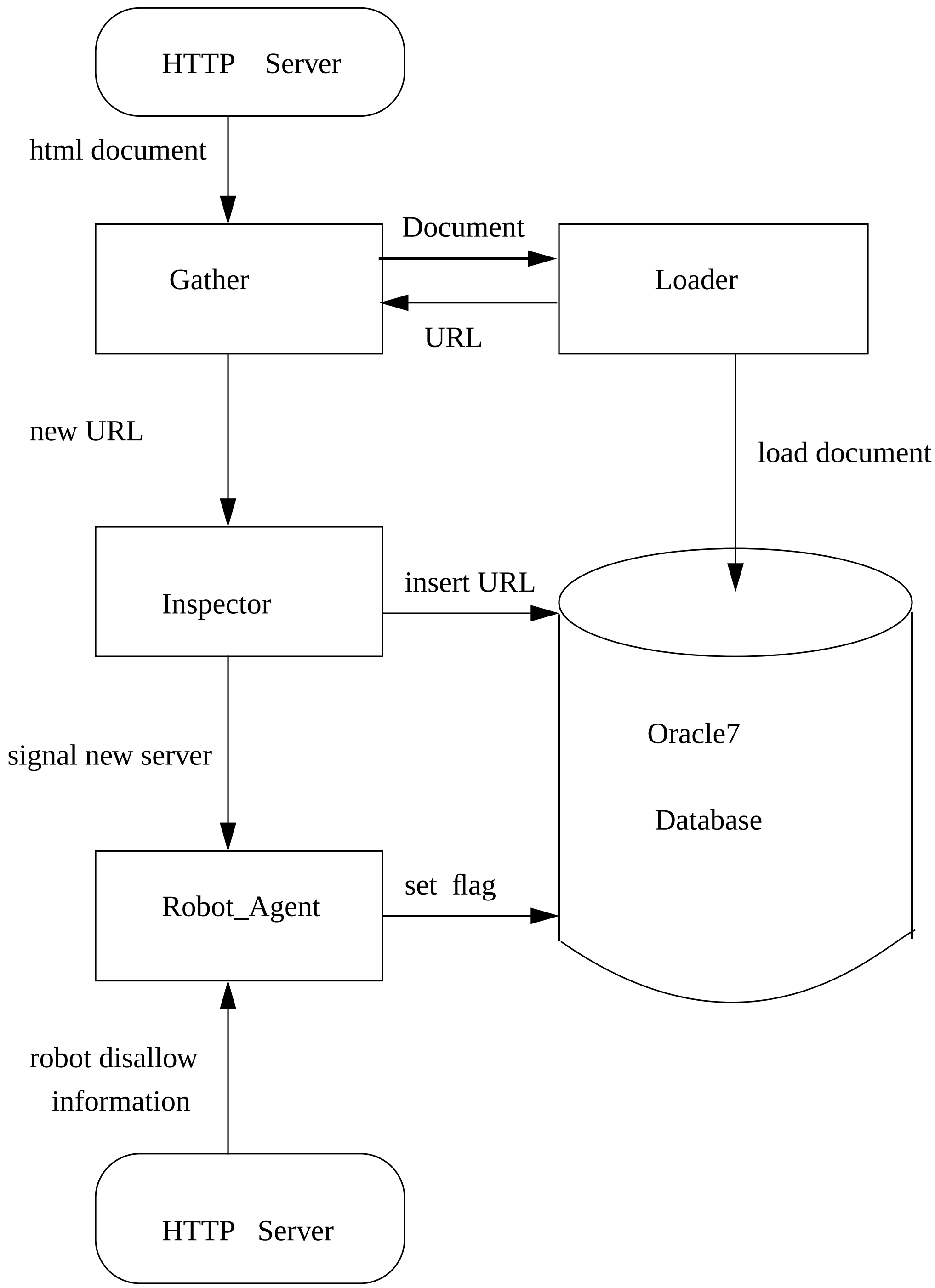
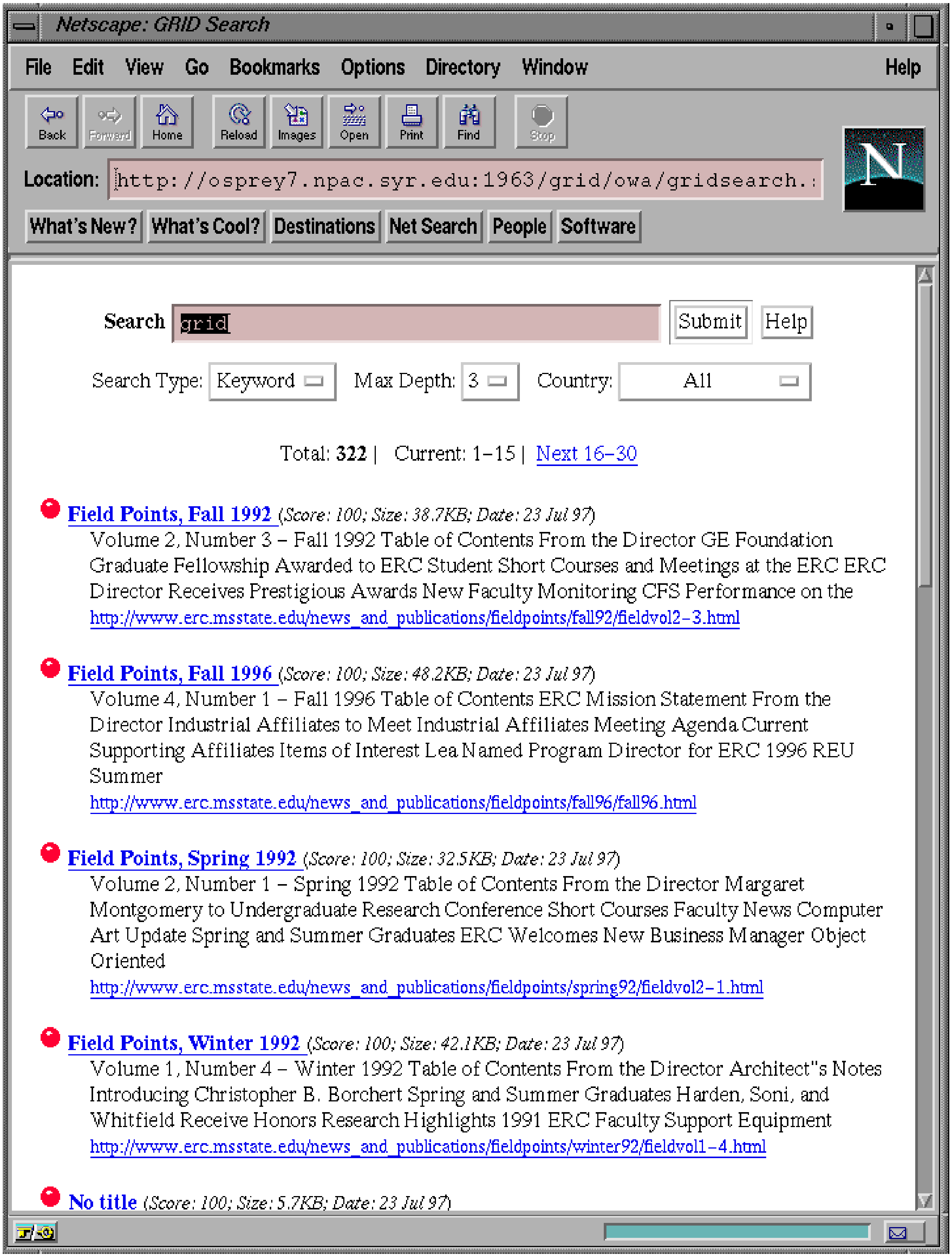



**Figure 1. Grid Robot System**

Netscape: GRID Search Engine
File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Reload Images Open Print Find Stop
Location: http://osprey7.npac.syr.edu:1963/grid/
What's New? What's Cool? Destinations Net Search People Software
Welcome
To
GRID Search Engine
Keyword Search: grid
Submit Help
Search Type: Keyword
Max Depth: 3
Country: ALL
GRID Search Engine is developed at Northeast Parallel Architectures Center at Syracuse University.
Send comments to Yuping Zhu


Figure. 2



Netscape: GRID Search
File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Reload Images Open Print Find Stop
Location: http://osprey7.npac.syr.edu:1963/grid/owa/gridsearch.:
What's New? What's Cool? Destinations Net Search People Software
Search grid Submit Help
Search Type: Keyword Max Depth: 3 Country: All
Total: 322 | Current: 1–15 | Next 16–30
Field Points, Fall 1992 (Score: 100; Size: 38.7KB; Date: 23 Jul 97)
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http://www.erc.msstate.edu/news_and_publications/fieldpoints/fall92/fieldvol2-3.html
Field Points, Fall 1996 (Score: 100; Size: 48.2KB; Date: 23 Jul 97)
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http://www.erc.msstate.edu/news_and_publications/fieldpoints/fall96/fall96.html
Field Points, Spring 1992 (Score: 100; Size: 32.5KB; Date: 23 Jul 97)
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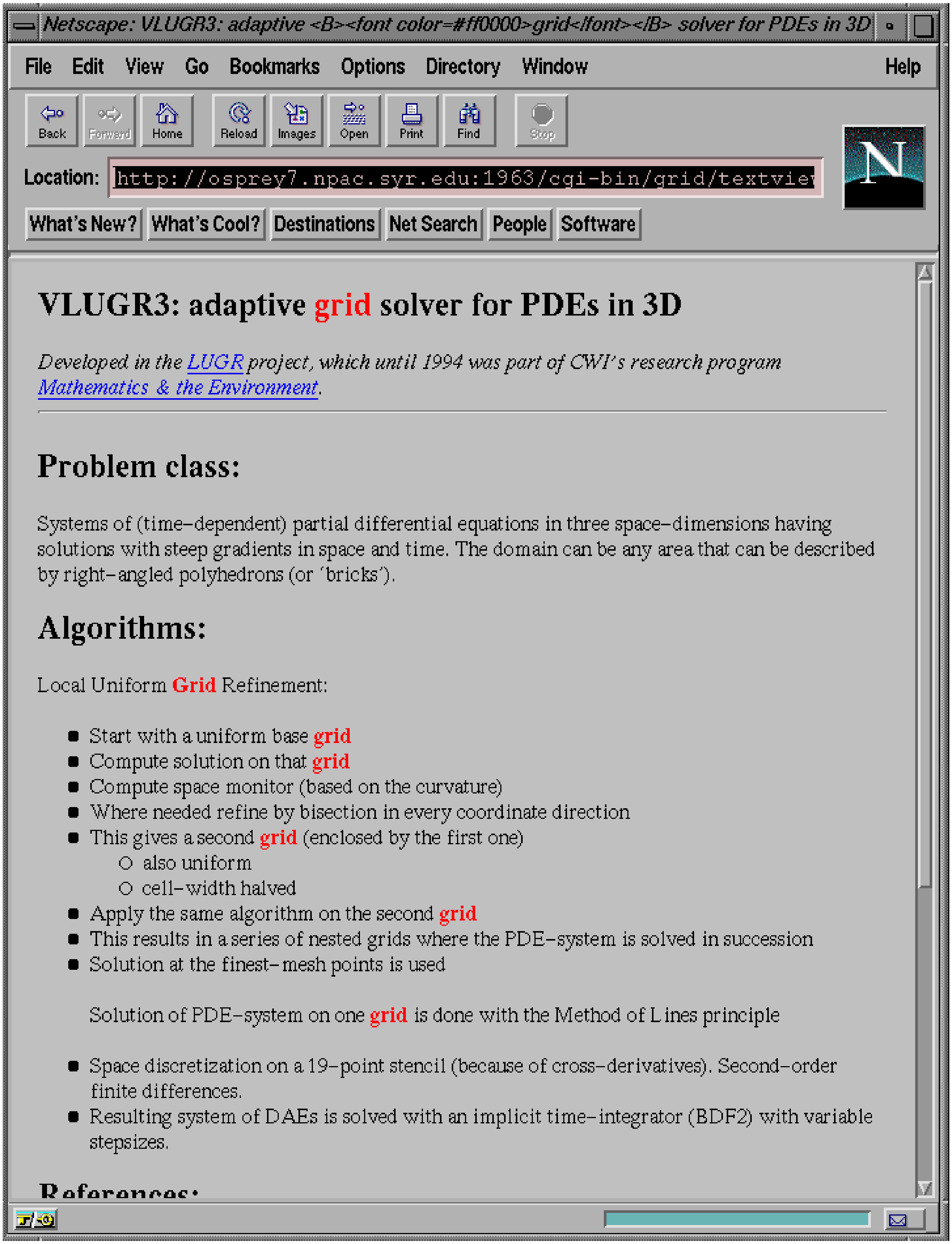
http://www.erc.msstate.edu/news_and_publications/fieldpoints/winter92/fieldvol1-4.html
No title (Score: 100; Size: 5.7KB; Date: 23 Jul 97)


Figure. 3




# VLUGR3: adaptive **grid** solver for PDEs in 3D

*Developed in the LUGR project, which until 1994 was part of CWI's research program Mathematics & the Environment.*

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## Problem class:

Systems of (time-dependent) partial differential equations in three space-dimensions having solutions with steep gradients in space and time. The domain can be any area that can be described by right-angled polyhedrons (or 'bricks').

## Algorithms:

Local Uniform **Grid** Refinement:

- Start with a uniform base **grid**
- Compute solution on that **grid**
- Compute space monitor (based on the curvature)
- Where needed refine by bisection in every coordinate direction
- This gives a second **grid** (enclosed by the first one)
  - also uniform
  - cell-width halved
- Apply the same algorithm on the second **grid**
- This results in a series of nested grids where the PDE-system is solved in succession
- Solution at the finest-mesh points is used

Solution of PDE-system on one **grid** is done with the Method of Lines principle

- Space discretization on a 19-point stencil (because of cross-derivatives). Second-order finite differences.
- Resulting system of DAEs is solved with an implicit time-integrator (BDF2) with variable stepsizes.

## References:

Figure. 4

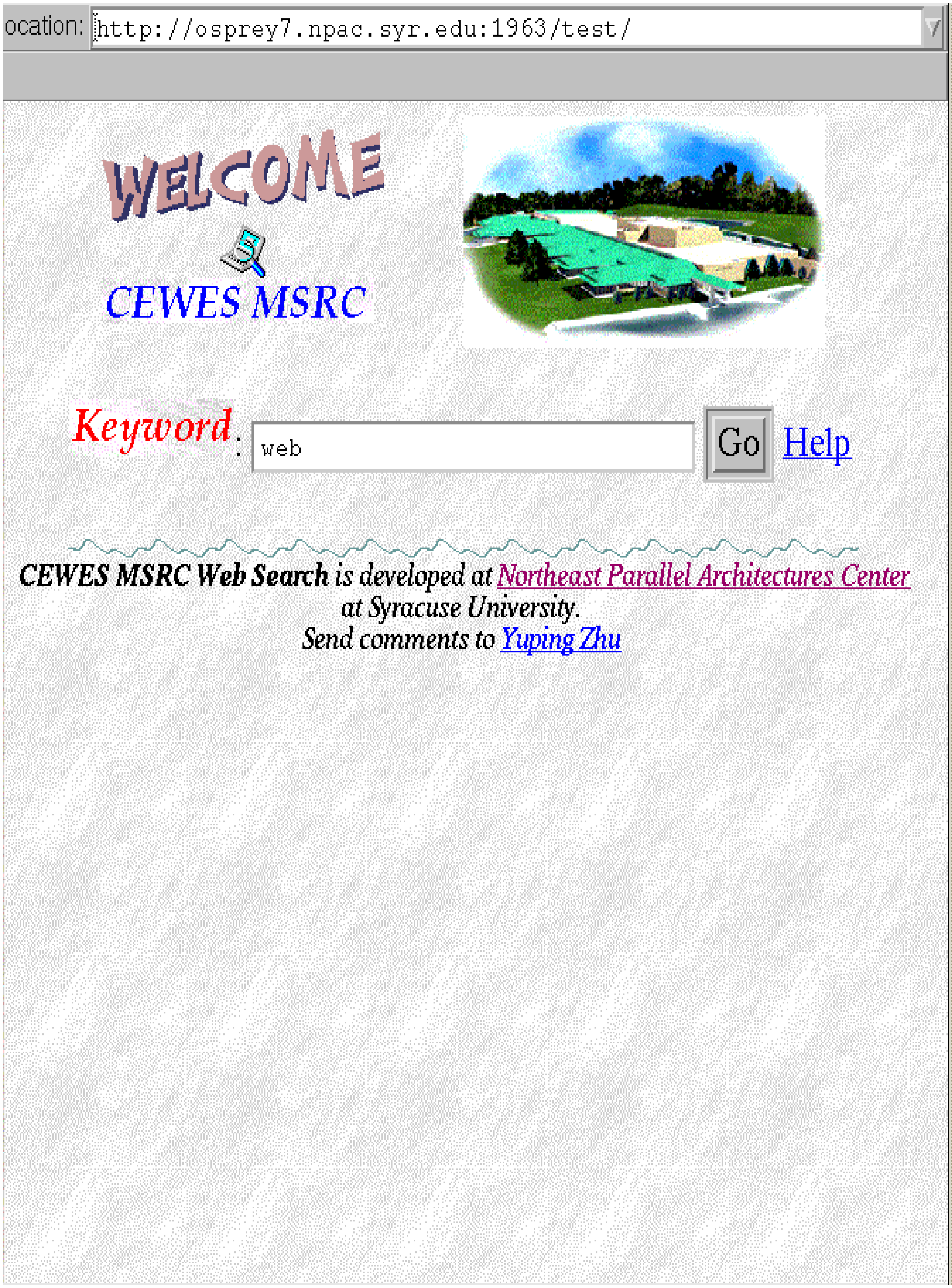

ocation: http://osprey7.npac.syr.edu:1963/test/
WELCOME
CEWES MSRC
Keyword:
web
Go
Help
CEWES MSRC Web Search is developed at Northeast Parallel Architectures Center
at Syracuse University.
Send comments to Yuping Zhu

Figure. 5

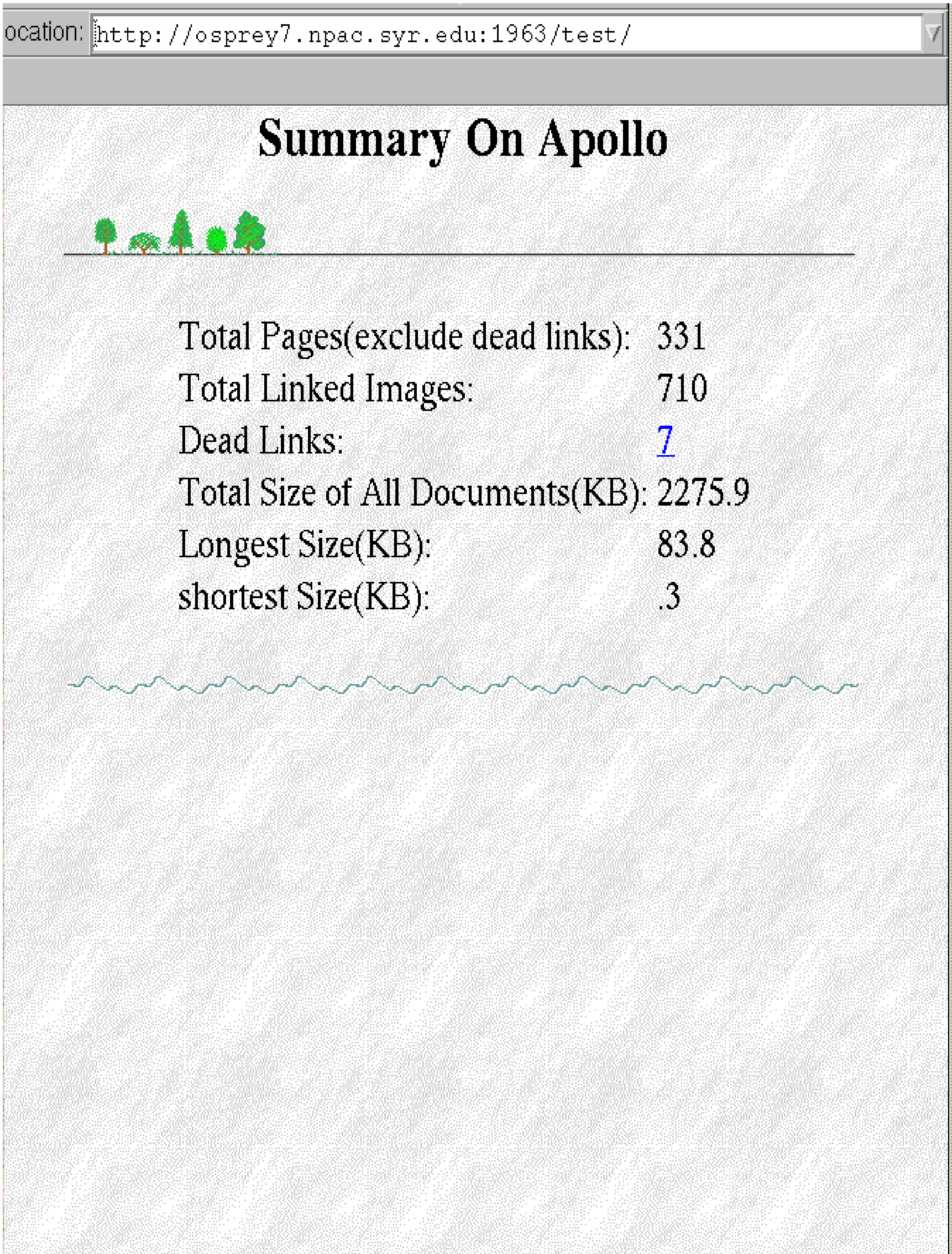
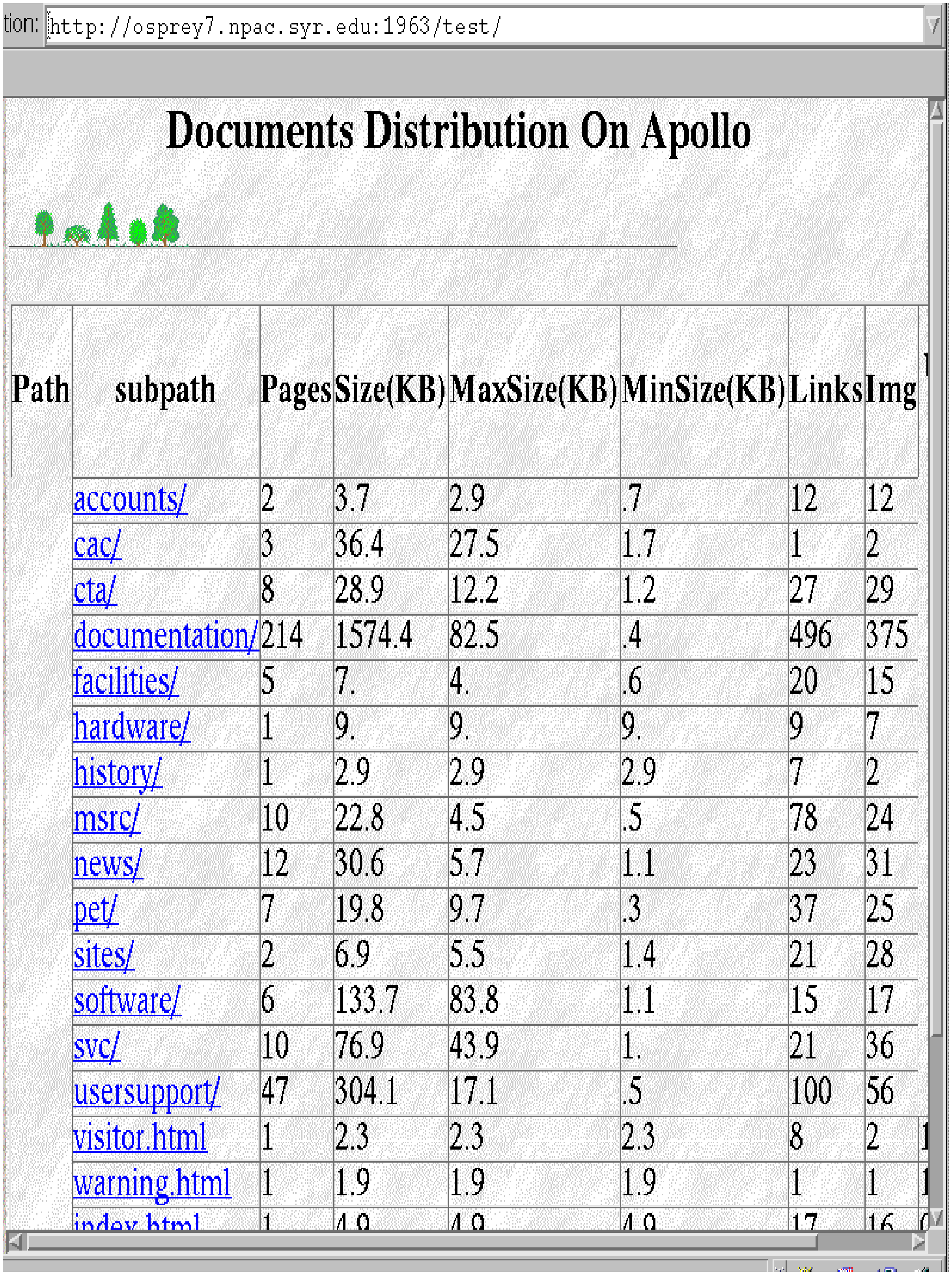

ocation: http://osprey7.npac.syr.edu:1963/test/
Summary On Apollo
Total Pages(exclude dead links): 331
Total Linked Images: 710
Dead Links: 7
Total Size of All Documents(KB): 2275.9
Longest Size(KB): 83.8
shortest Size(KB): .3

Figure. 6



tion: http://osprey7.npac.syr.edu:1963/test/

# Documents Distribution On Apollo

| Path | subpath | Pages | Size(KB) | MaxSize(KB) | MinSize(KB) | Links | Img |
|---|---|---|---|---|---|---|---|
| | accounts/ | 2 | 3.7 | 2.9 | .7 | 12 | 12 |
| | cac/ | 3 | 36.4 | 27.5 | 1.7 | 1 | 2 |
| | cta/ | 8 | 28.9 | 12.2 | 1.2 | 27 | 29 |
| | documentation/ | 214 | 1574.4 | 82.5 | .4 | 496 | 375 |
| | facilities/ | 5 | 7. | 4. | .6 | 20 | 15 |
| | hardware/ | 1 | 9. | 9. | 9. | 9 | 7 |
| | history/ | 1 | 2.9 | 2.9 | 2.9 | 7 | 2 |
| | msrc/ | 10 | 22.8 | 4.5 | .5 | 78 | 24 |
| | news/ | 12 | 30.6 | 5.7 | 1.1 | 23 | 31 |
| | pet/ | 7 | 19.8 | 9.7 | .3 | 37 | 25 |
| | sites/ | 2 | 6.9 | 5.5 | 1.4 | 21 | 28 |
| | software/ | 6 | 133.7 | 83.8 | 1.1 | 15 | 17 |
| | svc/ | 10 | 76.9 | 43.9 | 1. | 21 | 36 |
| | usersupport/ | 47 | 304.1 | 17.1 | .5 | 100 | 56 |
| | visitor.html | 1 | 2.3 | 2.3 | 2.3 | 8 | 2 |
| | warning.html | 1 | 1.9 | 1.9 | 1.9 | 1 | 1 |
| | index.html | 1 | 4.9 | 4.9 | 4.9 | 17 | 16 |

Figure. 7

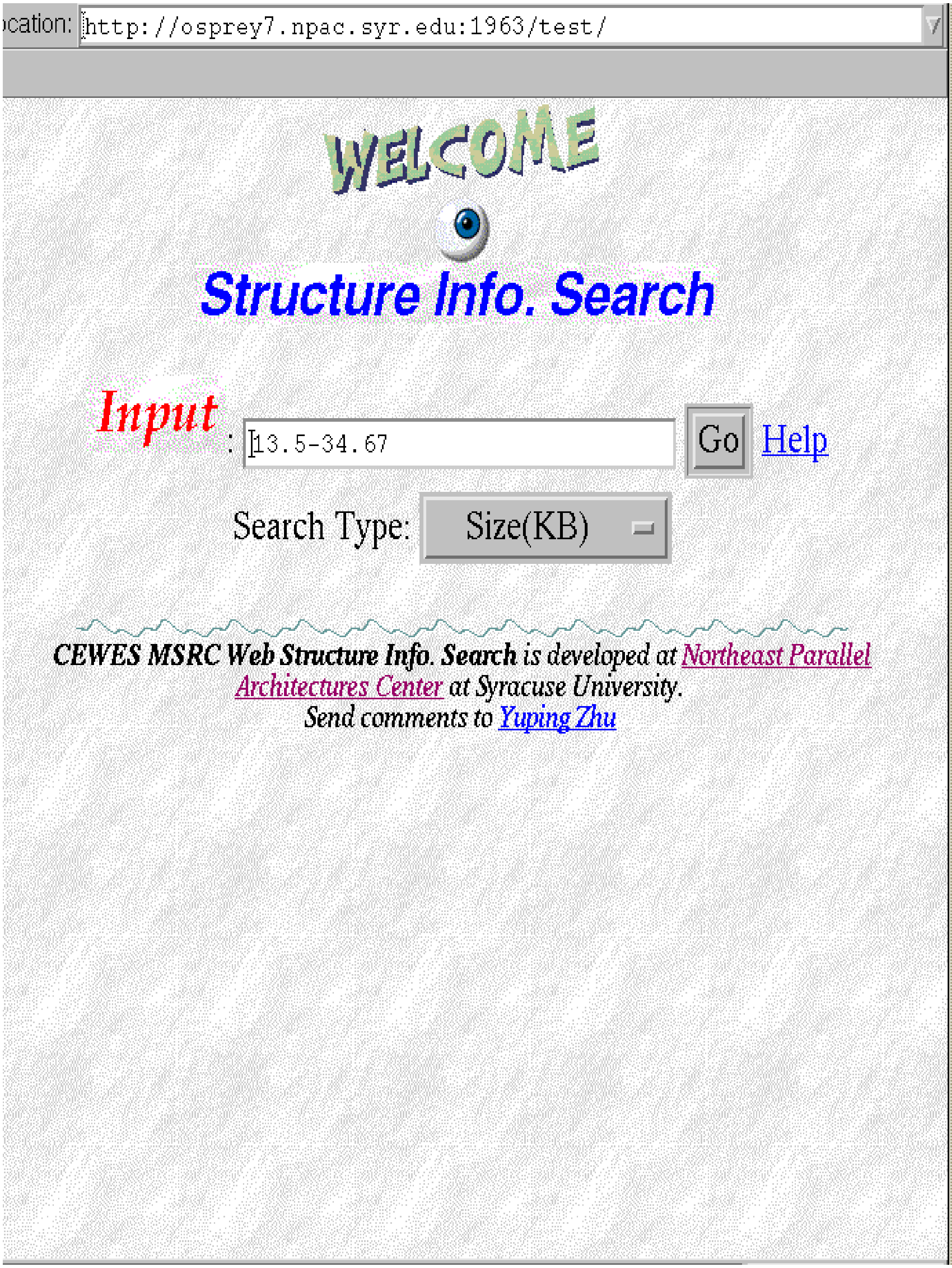

Location: http://osprey7.npac.syr.edu:1963/test/
WELCOME
Structure Info. Search
Input : 13.5-34.67
Go
Help
Search Type: Size(KB)
CEWES MSRC Web Structure Info. Search is developed at Northeast Parallel Architectures Center at Syracuse University.
Send comments to Yuping Zhu

Figure. 8